Study of Surface Topography, Roughness, and Microleakage After Dental Preparation with Different Instrumentation

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Purpose: The purpose of this study was to compare the differences in surface characteristics and roughness of teeth finished for porcelain veneer laminates using different instrumentation and to assess their influence on microleakage. ***Materials and Methods:*** Fifty-six extracted human maxillary central incisors were divided randomly into two groups: Group HsR teeth were finished with a high-speed handpiece with diamond burs; group SO teeth were finished with a sonic oscillating diamond instrument. Porcelain veneers were bonded to 24 teeth in each group. Microleakage was measured in the cervical area. Four remaining teeth in each group were examined using confocal laser-scanning microscopy and scanning electron microscopy. ***Results:*** Oscillating instruments produced a rougher dentinal surface (R_a values; $P = .029$) than those finished with high-speed rotary technology. ***Conclusions:*** There is less microleakage when bonded restoration edges are situated over dentin that has been finished with sonic oscillating instrumentation ($P = .006$). *Int J Prosthodont 2014;27: 530–533. doi: 10.11607/ijp.3932*

Due to the improvements in contemporary adhesive techniques, the indications for dental treatment with crowns have diminished in favor of more conservative techniques.[1] When teeth are prepared for porcelain veneer placement, this can result in dentin exposure in the gingival area due to the fineness of the enamel in this area.

The extent of microleakage beneath veneers is significantly greater when the edges of the restorations are over dentin than when they are over enamel, increasing the formation of cervical "gaps," which can intensify bacterial invasion and produce pulpal sensitivity and color changes.[2]

There is a relation between the instrument used for dental preparation and the dental surface produced, and some authors have recommended the use of either sonic diamond instruments that make oscillating movements or high-speed diamond or tungsten carbide rotary instruments. The surface roughness produced can influence wettability and bond quality.[3]

The aim of the present study was to compare the differences in surface characteristics and roughness of teeth finished with high-speed handpieces and oscillating instruments and to attempt to explain their clinical repercussions.

Materials and Methods

Fifty-six extracted human maxillary central incisors were divided into two groups (n = 28), using a randomization plan generated by www.randomization.com.

The authors made a simple standard preparation for porcelain veneer placement, reducing the vestibular face by 0.3 to 0.5 mm, with chamfered terminations at the gingival margin.[2]

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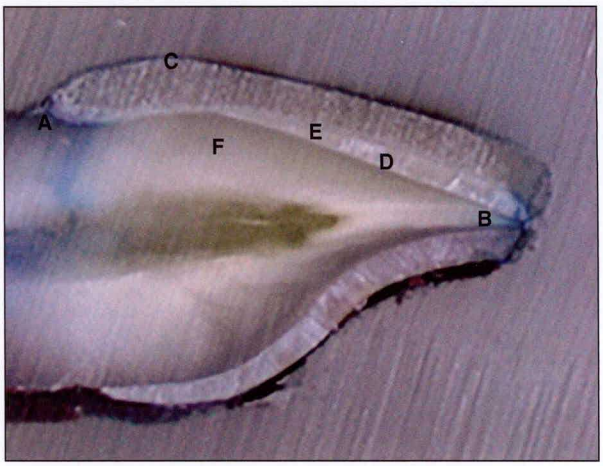

Fig 1 Microleakage was evaluated using an optical microscope. A = cervical microleakage; B = incisal microleakage; C = porcelain veneer; D = enamel; E = luting cement; F = dentin.

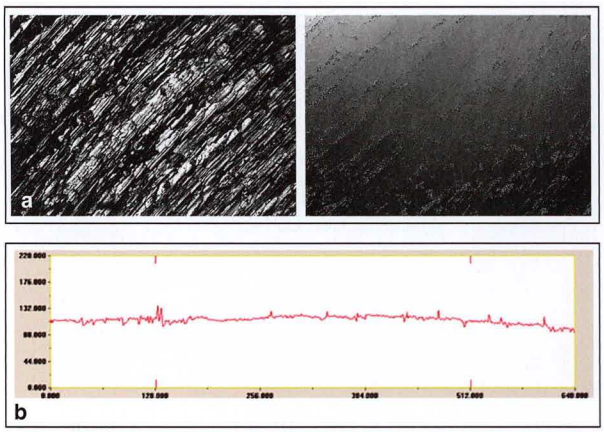

Fig 2 **(a)** CLSM micrographs showing irregular surface with parallel grooves characteristic of the high-speed rotary instrumentation used for group HsR. **(b)** Linear profile of image section.

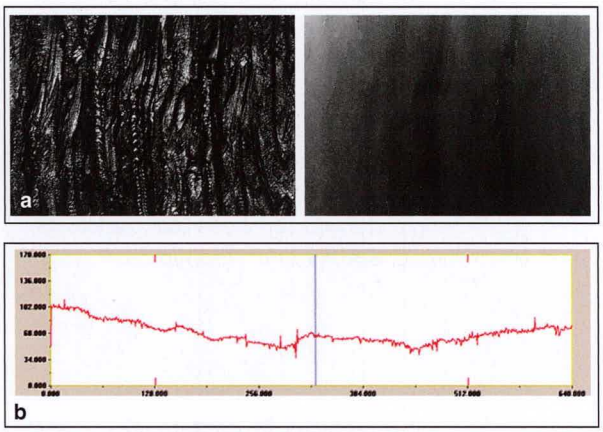

Fig 3 **(a)** CLSM micrographs showing irregular surface with deeper parallel grooves of pockmarked appearance and pits characteristic of the oscillating instrumentation used for group SO. **(b)** Linear profile is most irregular of image section.

Group HsR samples underwent dental finishing with a high-speed handpiece (Super Torque 660, KaVo) and a fine-grained (45 µm) diamond rotary instrument (Komet).

Group SO used sonic oscillating burs attached to a handpiece (Sonicflex 2003/L, KaVo) fitted with a fine-grained diamond instrument. Four remaining teeth in each group were kept apart to be examined with confocal laser-scanning microscopy (CLSM; Lext OLS3100, Olympus) and scanning electron microscopy (SEM; Jeol JSM 6300, Oxford Instruments) in order to observe the surface patterns produced and quantify surface roughness. A porcelain veneer (IPS Empress, Ivoclar Vivadent) was bonded to each of the 24 teeth in each group, and microleakage in the cervical area was measured using an optical microscope (OPMI pico [dental], Carl Zeiss) and a millimeter ruler (T3612-00, Leone), classifying cervical leakage as a percentage of leakage length in relation to total cervical-incisal veneer longitude (Fig 1).[4]

Statistical analysis was performed with the SPSS version 11.5 for Windows program (SPSS). Initial descriptive and bivariate analyses were conducted using the Kolmogorov-Smirnov test and the Mann-Whitney nonparametric test. The significance level established for bivariate analysis was 5% (α = .05).

Results

CLSM: Surface Roughness Measurement

In cervical areas, group HsR micrographs showed an irregular surface with ridges and parallel grooves, whereas group SO showed deeper grooves and pits characteristic of the movement of the oscillating instrument (Figs 2 and 3).

The linear roughness profiles of the images were obtained. Group HsR showed a median R_a value of 2.0 µm and R_z of 42.3 µm. For group SO, R_a was 3.4 µm and R_z 89.7 µm.

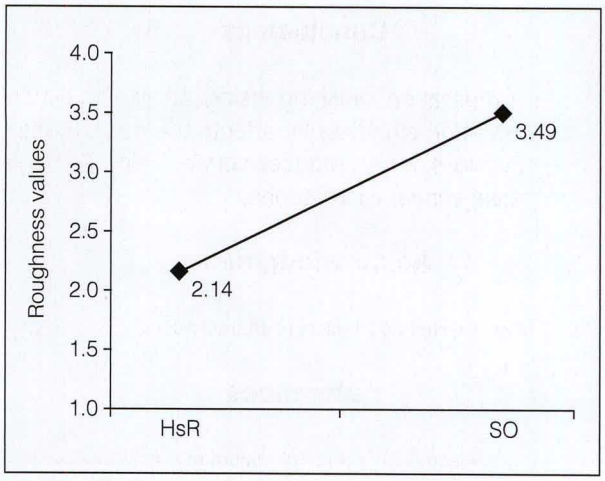

Fig 4 Roughness values (mean R_a) obtained for each group.

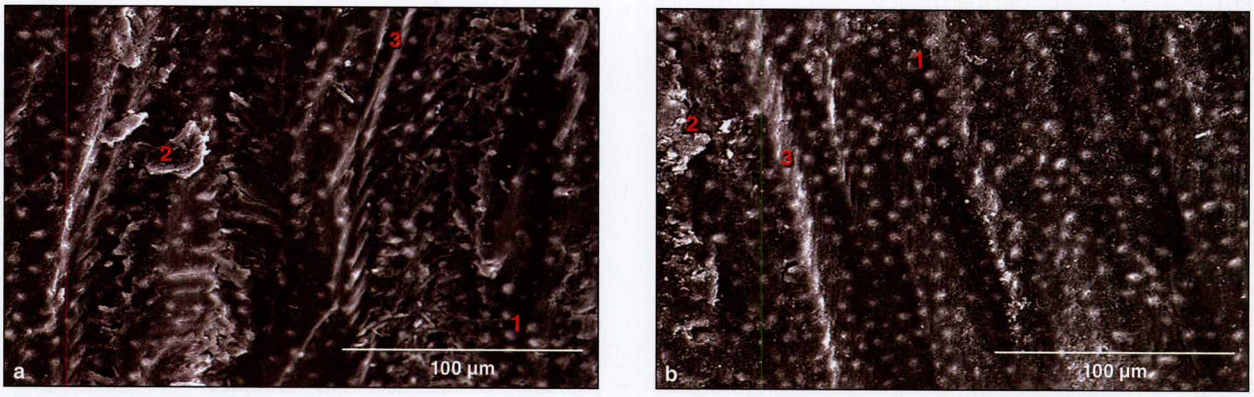

Fig 5 SEM micrographs of prepared tooth surface (cervical area, ×500 magnification) showing *(1)* dentinal tubules, *(2)* abundant dentinal smear, and *(3)* grooves produced by two types of instruments: **(a)** group HsR, irregular or roughened surface with a thick dentinal smear layer; **(b)** group SO, surface with deeper grooves and pits, smoother with less dentinal smear.

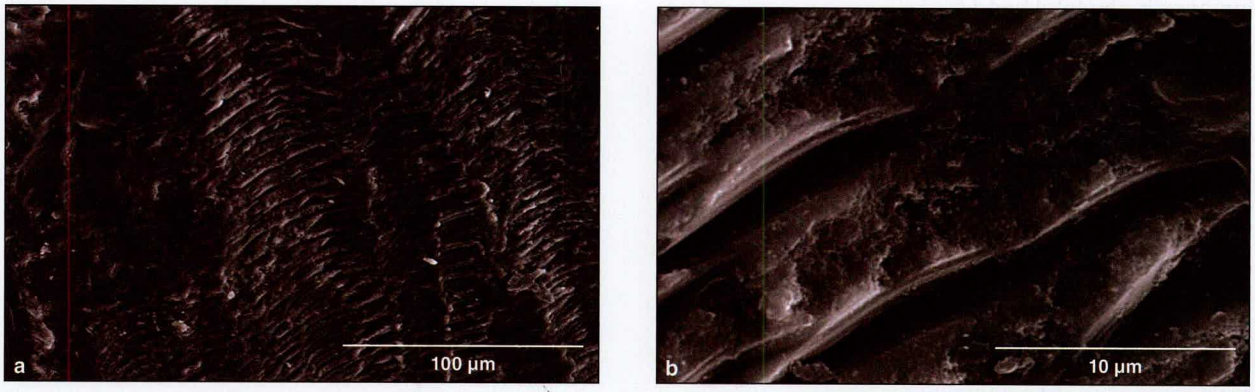

Fig 6 SEM micrographs of prepared tooth surfaces (cervical area: **[a]** ×500. **[b]** ×5,000 magnification) showing discontinuous grooves and pits characteristic of dentinal surfaces prepared using oscillating instrumentation.

Mean R_a at the group SO cervical margin was 1.6 times greater than group HsR, with statistical significance ($P = .006$; Fig 4).

SEM Evaluation

Cervical-scanning electron micrographs revealed sealed dentinal tubules, the dentinal smear layer, and an absence of enamel prisms. The two groups were seen to have different patterns of surface texture. Group HsR had parallel troughs, ploughed into the surface by abrading particles propelled by the high-speed instrument used. Group SO showed abrasive erosion, deep grooves of pockmarked appearance, discontinuous perpendicular troughs characteristic of oscillating instruments, and thin smear layers (Figs 5 and 6).

Microleakage Measurement

Cervical measurements found microleakage percentages of 10.5% in group HsR and 6.6% in group SO. A Mann-Whitney test was applied to compare microleakage distribution between groups; a statistically significant difference was obtained for cervical microleakage ($P = .006$).

Discussion

Dental preparation and the type of finishing procedure would appear to play an important role in the marginal adaptation of prosthetic restorations, although there is some controversy as to the influence of the grain size and material of the instrument used.[5] The present study used diamond instruments with the same grain size for both study groups.

The study quantified surface roughness parameters in the cervical margin area, obtaining a mean R_a similar to that of a study by Laufer et al.[6]

Group HsR samples were textured with shallow parallel grooves, made by abrasive particles passing across the tooth surface and ploughing troughs into the surface, propelled by the high speed of the instrument. An abundance of dentinal smear also was observed.

Group SO samples were textured with abrasion wear of pockmarked appearance, with discontinuous perpendicular grooves, where large particles had been torn away. The roughened texture produced an increase in the total bond surface area, which Ayad et al[3] claimed is a condition that favors wettability and so increases restoration retention.

Price and Sutow,[7] coinciding with the present study's findings, stated that the characteristic appearance of the dentinal surfaces is determined by the shape of the instrument used for finishing. The study's SEM micrographs showed less smear layer on cervical dentin finished with the oscillating instrument than with the rotary instrument, which might influence the bond achieved, given that Peumans et al[8] affirmed that after acid etching, most dentinal tubes do not remain completely free of smear layer.

Conclusions

Dental preparation finishing using sonic oscillating instrumentation significantly affects the dentin's surface roughness, which reduces cervical microleakage of porcelain veneer restorations.

Acknowledgments

The authors reported no conflicts of interest related to this study.

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